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ABSTRACT

Cognitive style is a potentially rich, but typically overlooked, source of individualization in computer based instruction (CBI). Using information about learners' cognitive styles in the design, development, and evaluation phases of CBI production can maximize individualization. In the design phase, for example, learners' cognitive styles can be assessed, using existing devices, and preliminary decisions can be made about what cognitive styles might be particularly important to the learner in accomplishing the learning objectives. Also in the design phase, the distribution of cognitive styles in the target population can be determined as a basis for decisions about the nature, grouping, and sequencing of instructional subtasks. In the development phase, cognitive styles can be matched with instructional strategies and activities, instructional media, and assessment tools. Finally, in the evaluation phase, a determination can be made about the extent to which the earlier matches between learning task demands and learners' cognitive styles, which were specified in the design and development phases, were appropriate. (LLS)

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COMPUTER-BASED INSTRUCTION AND COGNITIVE STYLES: DO THEY MAKE A DIFFERENCE?

by

Michael J. Cosky

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Computer-Based Instruction and Cognitive Styles: Do They Make a Difference?

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(Paper presented at the National Conference on Computer-Based Education, October 23-25, 1980: Bloomington, MN)

It is widely recognized that one of the chief advantages of computer-based instruction is its capacity to individualize the form, content, and pace of the learning to fit the learner. Designers, developers, and evaluators of computer-based instruction are typically interested in various characteristics of the learner (Control Data Education Company, 1978):

1) the learner's rate of comprehending and retaining the newly acquired information--his learning pace;
2) the learner's previously acquired knowledge of the to-be-learned material--his entry level knowledge;
3) what the learner wants to learn and how well he needs to learn it--his learning goals and proficiency levels; and
4) the learner's preferred mode of learning--how the learner learns best, or most comfortably.

All these considerations of the learner (and more) are important for instruction and learning to regarded as genuinely individualized.

However, my paper today will focus on the characteristic of the learner I mentioned last, namely the learner's preferred manner of learning. In order to discuss this attribute of the learner, I first need to rename it. I shall call it the learner's cognitive style, as hundreds of other theorists, researchers, and practitioners in psychology and education have. If it were only a matter of renaming, a kind of jargon-switching, my task here would be considerably easier.

But, a precise description of cognitive style is not so easily had, and more difficult still is the effective and efficient application of cognitive style theory and research to computer-based instruction.

Before I proceed with my description of cognitive style, please recognize that as a theoretical construct, cognitive style can (and does) mean different things to different people. This is not just a problem for the academic, the theoretician. Different conceptions of what cognitive style is, or isn't, also influence the nature of the research conducted to empirically validate these constructs, the instruments developed to measure the behavioral indices of these constructs, and the research findings from which interpretations, generalizations, and applications are made.

In my treatment of cognitive styles I have tried to paint as rosy a picture as possible. I have, at times, probably oversimplified and overgeneralized: I have perhaps orchestrated a kind of theoretical and empirical harmony where little or none exists. However, this was intended. Those who work in education, broadly defined, have to make decisions that, although informed by the appropriate theory and data, do not necessarily need to await the outcomes of the larger theoretical and empirical wars. (And, I am sure that you all have your own battles to fight.) Thus, in this paper I will deal with cognitive style in a way that I think will maximally inform you--and minimally mislead you. But, it is surely <u>not</u> the whole bloody story. So, with those caveats in mind, let us continue.

Cognitive style generally refers to an individual's characteristic and preferred way of knowing. <u>Cognitive</u>, derived from the Latin <u>cognitus</u>--meaning "to know", denotes a relation to the mental processes and structures used by an individual to "know" his environment. This "knowledge" of one's environment is a fairly complex and dynamic product of a number of mental operations.

Figure 1 in the handout depicts one such possible sequence of operations contributing to this knowledge--to one's "knowing" of his environment. Lets spend a few minutes taking a closer look at Figure 1.

As a cognitive psychologist, I recognize that this diagram, by virtue of what "boxes" I have chosen and labeled, what "arrows" I have drawn, and in what directions they are headed, has presupposed answers to certain important theoretical questions for which empirical support has yet to be realized. Nevertheless, I do not intend this graphic to be a statement of my own theoretical predelictions, but rather an illustration of generally what kinds of components play a role in human information processing, an illustration whose broad outlines would generally be acceptable by cognitive psychologists (for recent readable accounts, see Bourne, Dominowski, and Loftus, 1979; or Solso, 1979).

What is obvious, then, about such a view of cognition is that a narrow concept of learning, or a unitary notion of knowing, is woefully inadequate since the components in this sequence can, and do, influence and interact with each other. Further, I have made no mention of whether the incoming stimulus information available to the "knower" is visual or auditory, verbal or numeric. Such differences in sensory modality and type of information invariably complicate the rather simplistic view sketched in Figure 1. Thus, cognitive style refers to a dynamic constellation of human information processing operations, each of which contributes to what the individual "knows" about his environment.

How an individual <u>chooses</u> to interact with his enviornment, how an individual typically processes information, is where the <u>style</u> in cognitive style comes in. As proposed by Kostlin-Gloger (1978), the notion of cognitive style includes two aspects--abilities and preferences. Not only are there individual differences in cognitive abilities (e.g., some people deal more effectively with written material that with oral presentations), but there

are differences in cognitive preferences as well. As such, individual differences in cognitive styles presuppose differences in cognitive abilities--people typically prefer to exploit their strongest cognitive abilities. Hence, the style aspect of cognitive style carries with it clearly important motivational and personality factors. In fact, personality psychologists have helped to develop the theoretical construct of cognitive style (e.g., Wardell & Royce, 1978) and have provided evidence for its empirical validity (cf. Wolitzky & Wachtel, 1973, for a review). Thus, cognitive style clearly includes an affective dimension, influenced by personality, motivational, and emotional variables, in addition to the cognitive dimension described earlier.

What we see, then, is that cognitive style is really a broad and complex cover term used to describe relatively stable individual differences that relate both to the person's cognitive abilities and to his preferences for interacting with his environment--for knowing his world.

What about cognitive style theory and research and their relationship to computer-based instruction: what is known about cognitive styles, and how might this knowledge be applied to where it obviously (at least from our vantage point) belongs--to the individualized learning made available via computer-based instruction? For me, the answers to these questions are, in turn, "A lot." and "Very, very carefully."

Even though theory and research on individual differences in cognitive abilites is as old as psychology itself (beginning with the seminal studies of James McKeen Cattell [1890] and Sir Francis Galton [1879]); even though hundreds of papers and publications are produced annually on cognitive style; and even though disparate areas within psychology (e.g., experimental vs personality psychology), education, and development have contributed to this

endeavor; still, most of what can be said about cognitive styles has to be rather narrowly (and sometimes vaguely) stated. Such statements are usually limited to a specific cognitive style (say, field dependence/independence), qualified by the age of the experimental subject, the instrument used to measure that style, and a list of other person, situation, and task-related variables too long to provide here (see Wachtel, 1972; and Peterson and Scott, 1975).

Basically, the logic of the inquiry into cognitive styles goes (and has gone) something like this:

1) Individual differences appear to exist among people in terms of their abilities and preferences to process information.
2) What behaviorally identifiable components contribute to these individual differences in cognitive style, and what factors influence them?
3) What tests or tools can be developed to measure these behavioral components and to detect these individual differences in cognitive style?

The outcome of this somewhat fragmented approach has been the identification of some nine cognitive styles (Messick, 1970), or some 27 components of an individual's cognitive style (Hill, 1973).

Table 1 lists some of the more widely recognized cognitive styles, instruments used to measure them, and references to representative research. The cognitive styles listed in Table 1 have been empirically validated and are used to make predictions about the performances of cognitively complex, conceptually differentiated, leveling, field independent, and flexibly controlled people.

Although this methodological approach has resulted, as I implied earlier, in a wealth of information about each of a number of separate cognitive styles, considerably less can be said about the integration of these styles. What

can be said, for instance, about field independence, studied separately, might or might not be relevant to what we know about leveling, also studied separately, since research on the two components was invariably conducted with different experimental subjects, perhaps using different measurement techniques, employing different orienting tasks, etc. Thus, although we know a great deal about different cognitive styles and at least something about how some of them interrelate, in my view the state of the art does not yet appear to allow a straightforward application of this massive body of research and theory to computer-based education. Note that I am claiming that a straightforward and direct application appears unlikely: I am not asserting that what we know about individual differences in cognitive styles is useless for purposes of computer-based instruction. Far from it. I am simply arguing that if one wants to use contemporary theory and data on cognitive tyles to aid in the design, development, and evaluation of computer-based instruction, one ought to be very careful about such an application--or not bother at all.

Let me first clarify my rationale for this position, then I will suggest an approach to using cognitive styles that I consider more appropriate to the task.

As stated earlier, human information processing appears to be a dynamic constellation of a number of mental operations, of various interacting and integrated mental skills. These range from picking up the incoming stimulus information, to deciding how to use stored information in order to solve a problem. These components or subskills of human information processing interact and influence each other--for example, what we attend to and perceive is often influenced by our previous experiences with the to-be-preceived object. That is, the incoming stimulus information is mapped to stored representations in order to develop the perceptual result we call identification.

Thus, if the cognitive styles (as noted in Table 1, for instance) systematically relate to the subskills of human information processing--and surely they must, then it is imperative to know more than what the separate cognitive styles accomplish individually. In as much as the cognitive psychologist has ceased to consider perception, learning, memory, language and thinking as clearly separable psychological constructs, so too a more reasonable application of cognitive style theory and research to computer-based instruction will recognize the interactive nature of cognitive styles and their intra-individual components. It is simply not known whether the cognitive styles described earlier represent mutually distinct processes, or how each is psychologically different from the others (Wardell & Royce, 1978).

Therefore it seems to me that in view of the nature of the research on cognitive styles, workers in computer-based education will have to glean very carefully, from what at first blush appears to be a bountiful harvest of research, only those kernels of data appropriate to the mastery of the learning materials being designed and developed and to the cognitive styles of the learners who will use those materials. Therein lies the "very careful" use of cognitive style theory and data.

My suggestion, then, is to maximize the individualization available in computer-based instruction by exploiting the learner's cognitive styles. Minimally this will involve activity in the design, development, and evaluation phases of creating computer-based instruction. (Here is where I regrettably and unavoidably lapse into jargon; those of you unfamiliar with it please bear with me!).

1) Design Phase

A) When defining the target population (accomplished during needs analysis), assess the learners' cognitive styles. A number of devices exist for such an assessment; generally the more expensive they are (in terms

of time and money), the more information they will provide about the learner.

B) Make some preliminary decisions about what cognitive styles, or what elements of a cognitive style, might be particularly important to the learner in accomplishing the learning objectives. Namely, what are the cognitive style demands of the learning task(s)? It is advantageous if some of these decisions, dealt with during the instructional task analysis, can be made early on: testing devices for specific cognitive styles (e.g., the Stroop Color-Word Test) are usually less expensive than the battery or profile type of test (Cognitive Style Mapping Inventory; Hill, 1973).

C) Determine how the target population distributes itself along those earlier identified "important" cognitive styles.

D) Note the cognitive styles of the target population, and recognize their importance to the nature, grouping, and sequencing of the instructional subtasks.

2) Development Phase

A) When designing the assessment system and writing test items, match assessment to the cognitive styles in the target population.

B) When determining instructional strategies and developing instructional activities, match instruction to the cognitive styles in the target population.

C) When selecting instructional media, match mode of presentation to the cognitive styles in the target population.

3) Evaluation Phase

A)When conducting the pilot test during the formative evaluation, use a sample whose cognitive styles accurately reflect those in the target population.

B) During both the summative and the field evaluation, determine the extent to which the earlier matches between learning task demands and the learners' cognitive styles, specified in the design and development phases, were appropriate.

This is clearly an ambitious program. But I submit that it is just as necessary as ambitious if cognitive styles are worth our attention at all.

It is important to note that there are some built-in savings when using the scheme outlined above. First, suppose that the target population is fairly homogeneous with respect to cognitive styles, that for whatever reason only a few cognitive styles predominate in the target population. In such a situation it may be possible to reduce the usual number of instructional strategies and activities, the number of types of test items, and/or the number of different instructional media--without reducing the extent to which the instruction and the learning are individualized. That is, learning materials that won't be used, simply don't get designed.

Another situation might exist in which the cognitive styles of the target population are heterogeneously distributed, that no clear cluster of cognitive styles emerges in the target population. Further design and development relative to cognitive styles might be curtailed if such work would not prove to be cost effective. That is, it would be prohibitively expensive to design, develop, and evaluate a number of strategies and activities, test item types, and media (all keyed to a number of different cognitive styles) if only a few members of the target population prefer a particular cognitive style--which is exactly what would be the case in a fairly heterogeneous distribution of cognitive styles. In this latter case there may simply be too many cognitive styles in the target population to exploit efficiently and economically.

Other situations can be imagined, but I think it is clear that a judicious

application of cognitive style theory and data does not necessarily mean higher cost; I also think it means a better product.

The suggestions offered here,although arrived at independently, resonate to those proposed in an article by Ausburn and Ausburn (1978). They also argue that cognitive style is a potentially rich, but typically overlooked, source of individualization in computer-based instruction. Focusing more on the cognitive style demands of the learning task, they propose that the instructional design and development supplant for the learner those cognitive styles (or elements thereof) necessary to master the learning task. In their words:

> ...supplantation (is) defined as the explicit and overt alteration or performance of a task requirement which a learner would otherwise have to perform for himself. By employing an instructional treatment that supplants for the learners the process they are unable to perform, a bridge is formed that completes the learner/task link and enables a successful performance (p 343).

Thus, Ausburn and Ausburn emphasize the cognitive style demands of the learning task and how instructional design ought to facilitate and make more obvious, more accessible, exactly those cognitive components central to mastering the learning task. This approach does not necessitate the perhaps costly evaluation of the target population's cognitive styles (as I suggested was necessary), but such an evaluation would clearly strengthen the precision of the instructional design and the quality of the resulting product. In fact, research conducted by Floyd Ausburn (1975) confirmed the importance of the learner's cognitive style as it interacts with the supplanted learning materials.

At this juncture, then, it should be clear that exploiting cognitive style, whether focusing on the learner, the demands of the learning task, or their interaction, is a potentially productive means of genuinely individualizing computer-based instruction. However, research designed to test the suggestions outlined above have been noticeably lacking, and applications even less abundant.

There are, I suppose, lots of good reasons for this dearth of data; some of the reasons may be economic, some theoretical--certainly none are educational. Although I have rather cavalierly suggested to "match instructional actvities, media, and assessment to the cognitive styles of the learner and to the demands of the learning task," this matching, or Ausburn's supplanting, does not come easily, and it is admittedly made even more difficult by the absence of relevant research.

Hence, I issue a challenge to the research community in cognitive psychology and education, and to those who do the "real world" work of designing, developing, and evaluating computer-based instruction. Providing more nearly individualized instruction is within their collective grasp.

We have long known, from the wise elders of Greece and Rome to the contemporary British tutorial system, that instruction tailored to fit the learner works well, maybe even best. Such instruction was until now only available to the elite. I think we can do better: we now have the wherewithal to provide such learning for all those who desire it.

Thank you for your attention.

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Figure 1

Typical Sequence of Human Information Processing

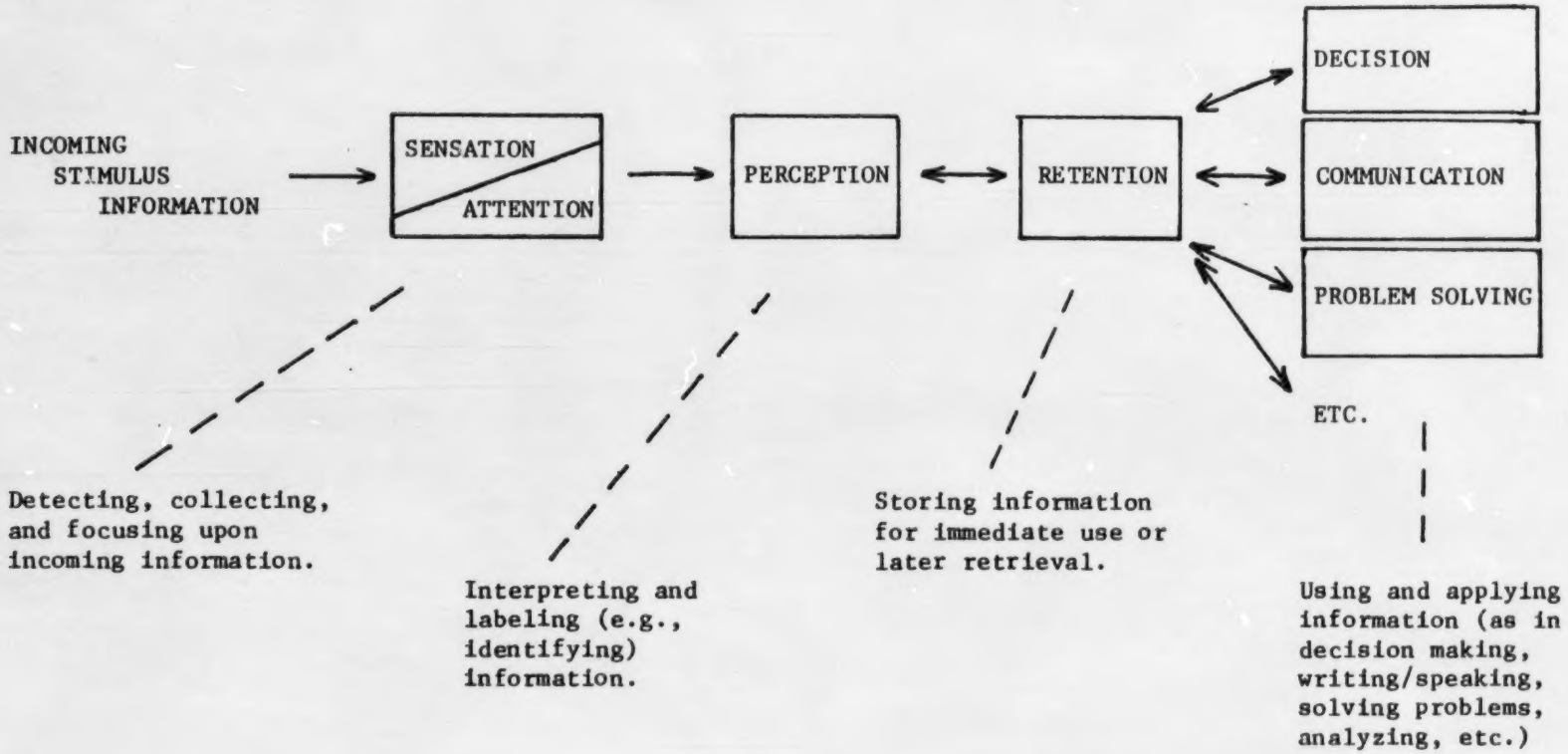

Table 1

Descriptions of Selected Cognitive Styles, Instruments Used to Measure Them, and Research References (cf. Wardell & Royce, 1978; and Kagan & Kogan, 1970).

Cognitive Style	Instrument(s)	References
1) Cognitive Complexity The extent to which a person uses his cognitive structures when processing information, refers new information to pre-existing cognitive structures, makes conceptual distinctions, abstracts and integrates information--flexible and independent of the judgements of others.	Role Construct Repertory	Bieri & Blacker (1967) Gardner & Schoen (1962) Langley (1971)
2) Conceptual Differentiation The ability to bring a large number of concepts to bear on a cognitive task; related to the number of distinct conceptual discriminations made on the subject matter.	Object sorting tasks (using various types of stimulus materials)	Gardner & Schoen (1962)
3) Leveling/Sharpening The extent to which a person assimilates new and old information in memory; conversely, the tendency to be hypersensitive to minutiae, to respond to small differences in memory, to exaggerate change.	Judgement of sequentially presented stimuli. Serial reproduction of stories.	Klein (1951) Holzman (1954) Gardner & Lohrenz (1960)
4) Field Independence/Dependence An analytical way of perceiving which enables items (information) to be experienced as discrete from their backgrounds, to be able to overcome the influence of context.	Body Adjustment Test Embedded Figures Test Rod-and-Frame Test	Witkin, et al (1954, 1962 & 1967)
5) Constricted/Flexible Control The extent to which an individual is susceptible to distraction and cognitive interference in tasks containing conflicting cues.	Stroop Color-Word Interference Test	Klein (1954) Jensen & Rohwer (1966) Stroop (1935)

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